



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

November 13, 2000

Sector Captain Suffers Fatal Heart Attack - Texas

SUMMARY

On January 17, 2000, a 53-year-old male Sector Captain (the victim) was rendering assistance to a civilian when he collapsed. The civilian, certified in cardiopulmonary resuscitation (CPR), initiated CPR for approximately 1 minute before calling for emergency assistance. Engine company personnel within the Captain's sector and an ambulance staffed with emergency medical services (EMS) personnel arrived on scene simultaneously within 2 minutes of emergency dispatch. Upon arrival, fire fighters and EMS reinitiated CPR and initiated advanced cardiac life support (ACLS). Despite ACLS on scene, en route, and at a local hospital emergency department (ED), the victim died. The death certificate, completed by the Justice of the Peace, listed "myocardial infarction" (heart attack) as the immediate cause of death, and "diabetes" as a significant condition contributing to the death. An autopsy was not performed.

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty heart attacks and cardiac arrests among fire fighters. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity. Issues relevant to this Fire Department include:

- *Fire Fighters should have periodic medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

- *The Fire Department's physician should approve, in a confidential, nondiscriminatory manner, all medical information and recommendations for return-to-work clearances from personal physicians.*
- *Individuals with medical conditions that would present a significant risk to the safety and health of themselves or others should be precluded from fire fighting activities.*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*

INTRODUCTION AND METHODS

On January 17, 2000, a 53-year-old male Sector Captain collapsed while rendering assistance to a civilian. Despite immediate resuscitative efforts administered by the civilian, fire fighters, emergency

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

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medical and ED personnel, the victim died. On February 7, 2000, NIOSH contacted the affected Fire Department to initiate the investigation. On February 22, 2000, NIOSH investigators from the Fire Fighter Fatality Investigation Team, Cardiovascular Disease Component, traveled to Texas to conduct an on-site investigation.

During the investigation NIOSH personnel met with or interviewed the:

- Fire Chief;
- Assistant Fire Chief;
- City's Legal Risk Manager;
- Deputy Chief for Risk Management;
- Deputy Chief for Training;
- Local International Association of Fire Fighters (IAFF) representative;
- Fire Department physician responsible for medical evaluations;
- Fire Station personnel involved in this incident;
- Civilian witnessing incident;
- Emergency medical personnel providing treatment;
- The victim's personal physicians;
- The State Fire Marshal.

During the site-visit NIOSH personnel also reviewed:

- Fire Department incident report;
- Fire Department policies and operating procedures;
- Fire Department training records;
- Fire Department annual run summary;
- Fire Department administrative records;
- Ambulance response report;
- Hospital ED records;
- Past medical records of the deceased;
- Death certificate.

INVESTIGATIVE RESULTS

Emergency Scene Response. On January 17, 2000, at approximately 2040 hours, while he was surveying areas within his sector's district, the Sector Captain (the victim) recognized an automobile at a business office that would normally not be present at that hour. The victim entered the building and found a civilian who had returned to the office to prepare for an upcoming inspection. The victim rendered assistance by helping carry empty cardboard boxes outside to a garbage bin behind the building. This assistance, described as non-strenuous, was provided to ensure the civilian's personal safety by reducing the time she was alone in the office at night.

After removing the trash items, the victim told the civilian that he was not feeling well and asked for a piece of hard candy. The civilian knew the victim was diabetic and gave him a piece of candy. When she completed her work and went to turn off her computer (which was in the same room, but separated by a modular partition) she heard the victim collapse. The civilian found the victim face down on the floor, and she was able to roll him on his back and remove the candy from his mouth. The civilian reported that the victim appeared to be in severe distress. She thought he attempted to speak to her. Less than a minute after collapsing, at approximately 2050 hours, the victim stopped breathing and the civilian could not palpate a carotid pulse. She initiated CPR for approximately 1 minute before calling her on-duty-husband/fire fighter, reported that she thought the victim was having a heart attack, and requested emergency assistance. The fire fighter alerted the in-house crew and dialed 911 for EMS dispatch. At 2053 hours, EMS was alerted and an ambulance with one emergency medical technician (EMT) and a paramedic was dispatched. At 2055 hours, they arrived on scene and were met by seven fire fighters who arrived in an engine pumper and ladder truck.

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Upon arrival, EMS and fire fighters reinitiated CPR, and the victim was hyperventilated with oxygen via a bag-valve mask. An automated external defibrillator was connected to the victim and displayed a heart rhythm of ventricular fibrillation (V. fib.). A 200-joule charge was delivered, resulting in pulseless electrical activity (PEA). An initial attempt at intubation was unsuccessful and the victim was transferred to the ambulance. CPR was continued, the victim was successfully intubated, and a peripheral intravenous (IV) line was established. IV medications consistent with ACLS protocol were administered in the ambulance, and the victim's heart rate returned to V. fib. as transport to a local ED began at 2108 hours. Six attempts at cardioversion were made with electrocardiogram (EKG) rhythms changing from V. fib. to asystole to PEA with each defibrillation and ACLS medication administration during the 8-minute ride to the ED. The victim's care was transferred to the ED at 2120 hours.

The victim arrived in the ED in full cardiac arrest. ACLS was continued for an additional 31 minutes before resuscitative efforts were discontinued and he was pronounced dead at 2151 hours. Blood specimens drawn in the ED indicated that a blood enzyme specific for myocardial infarction (MI) was slightly elevated. (This enzyme usually reaches a confirmatory MI elevated level 2 to 8 hours after an MI, however, the victim did not survive that long.) His ED EKG pattern displayed an acute MI.

Medical Findings. The death certificate, completed by the Justice of the Peace, listed "myocardial infarction" as the immediate cause of death, with "diabetes" being a significant condition contributing to the death. An autopsy was not performed.

The victim had severe coronary artery disease (CAD). In 1981, the victim had a three-vessel coronary artery bypass graft following a "silent MI." He missed 50.5 days of work, and when he returned

to work, Fire Department records indicate that his physician precluded him from any fire suppression activities for an additional 4 months. No medical records could be located following that incident until 1994, when he went to see a local physician. During this visit, medical records stated that he was experiencing "unusual chest pains." He was diagnosed with high blood pressure, diabetes mellitus, and high cholesterol and described as moderately obese. He was prescribed medications and dietary restrictions for all these conditions and referred to a cardiologist (heart specialist) for an exercise stress test (EST). Results from the EST were reported to be "entirely normal . . . almost completing Stage III of a Bruce protocol EST, limited mostly by some leg pain." The cardiologist noted that his previous coronary artery grafting was functioning well but did recommend increased aerobic activity and compliance with recommendations of his other local physician. Medical records note that the victim did not follow-up with this physician, but 2 years later, on two separate occasions, the physician's office did call pharmacies to refill the victim's cholesterol-lowering medication.

In 1996, the victim awoke from sleep with severe chest pain which radiated down his left arm. He was admitted to a local hospital with unstable angina (heart pain). An acute MI was ruled out by serially repeated EKGs and blood specimens (cardiac isoenzymes). A coronary angioplasty was performed, and areas of severe ischemia (inadequate blood flow to the heart) were identified in the left anterior descending coronary artery. A stent (a device placed inside a narrowing heart vessel to expand it) was placed within this artery.

The victim was discharged home after 2 days and followed up only once with his local physician, 3 weeks after discharge. Department records on file from the treating physician state "No fire fighting, may direct operations." The victim missed 6.5 days of work.



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The day of his death was the first day back after a 4-day scheduled leave. He spent the day in meetings and performing administrative duties. There were no calls within his sector that day. He told colleagues that 3 days prior to his death, while on a hunting trip, he had taken two nitroglycerin tablets to relieve chest pain. (No physicians interviewed during this investigation prescribed nitroglycerin for the victim.)

His colleagues reported that the victim stated he had been experiencing numbness in his hands and left arm for weeks. They described that he increasingly became diaphoretic and short of breath while engaged in nonexertional activities. His friends and colleagues were concerned and encouraged him to be medically evaluated.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the Fire Department consisted of six stations serving a population of approximately 105,000 in a geographic area of 46 square miles. Occasionally, response outside this area is necessary, and mutual aid agreements exist with surrounding cities and a rural county. Administratively, the Department is organized into five divisions (Risk Management, Training, Operations, Fire Prevention, and Support), each directed by a Deputy or Assistant Chief who reports to the Fire Chief. The Operations Division staffs the fire stations and is divided into two sectors (Sector One and Sector Two), each directed by a Sector Captain (comparable to a Battalion Chief).

At the time of this investigation, there were 128 paid, certified fire fighters. Fire fighters work a 24-hour-on, 24-hour-off cycle for three consecutive rotations. At the end of the third rotation, Operations personnel get 4 days off before beginning a new cycle. In 1999, the Department responded to 1,878 calls: 21% fire suppression activities, 50% investigative,

17% hazard removal, 5% extrication and 7% "other" (e.g. false alarms, shorted electrical equipment, or "not otherwise classified").

Each station has sleeping quarters for all personnel, a lounge area, and a kitchen and dining area. Additionally, each station is equipped with aerobic (e.g. stair-steps, stationary bicycles) and strength (free weights) exercise equipment, which employees are encouraged to use.

Training. Fire fighting training for the Department is coordinated by the Training Division Deputy Chief, who is certified by the Texas Commission on Fire Protection (TCFP) as an instructor for the Texas Firefighting Academy. Only persons with a high school diploma (or GED), 18 years of age, and U.S. citizens (or resident aliens) who are certified or certified-eligible may apply as fire fighters. Certified-eligible candidates have completed a core curriculum of 458 hours of training and passed a written examination. They then must complete 44 hours of Emergency Care Attendant training (similar to Basic Life Support) and complete a physical skills test demonstrating competency in such areas as hose coupling, ladder set-up, self-contained breathing apparatus use, engine driving, and rescue equipment.

When a candidate passes these requirements, they can be hired as a Basic Firefighter (similar to Fire Fighter Level I). A minimum annual requirement of 20 hours of continuing education is necessary to maintain certification. After 4 years of duty, and completion of 96 hours of classes, a fire fighter is eligible for promotion to Intermediate Firefighter. After 8 years of duty and an additional 96 hours of classes, a fire fighter is eligible for promotion to Advanced Firefighter. Courses required for these promotions must be National Fire Academy Field Courses. The victim was an Advanced Firefighter employed by this Department for 32 years. He became Sector Captain in 1989.

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Pre-Employment/Pre-Placement Medical Evaluations. The Department requires pre-employment medical evaluations of all new hires. These are conducted by an occupational medicine physician retained by the Department. In a telephone interview with this physician, he stated the evaluation includes

- Complete medical history;
- Physical examination, including vital signs;
- Complete blood count;
- Cholesterol and triglycerides;
- Urinalysis (including glucose levels and drug screening);
- Spirometry;
- Resting EKG;
- Stress EKG;
- Chest X-ray;
- Hearing test;
- Vision test.

This examination was based on an earlier version of the National Protection Association (NFPA) standard, *Medical Requirements for Fire Fighters*. (At the physician's request, he was provided a 1997 revised edition.)

Periodic Medical Evaluations: Periodic evaluations are provided only to those individuals promoted to a higher rank within the Department. This evaluation includes:

- Complete medical history;
- Urine drug test;
- Hearing test.

Fire fighters missing three or more consecutive days of duty must provide medical clearance from their personnel physician. This information is filed in Department records and not reviewed by the Department's physician.

Annual physical agility testing (PAT) was stopped by the Department in 1984 due to the number of injuries occurring during the testing.

DISCUSSION

V. Fib. is the most common type of arrhythmia associated with cardiac arrest, occurring in 65-80% of all cardiac arrests.¹ In the United States, atherosclerotic coronary artery disease (CAD) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include age greater than 45 years, male gender, family history of CAD, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.² The victim had severe CAD, numerous risk factors, and coronary-artery-bypass grafting 19 years prior to his death.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.³ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁴ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁵ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques.

Blood clots, or thrombus formation, in coronary arteries is initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.⁴ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.^{5, 6} Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.⁷⁻¹⁰

Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been

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shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.¹¹⁻¹³ The victim was not engaged in any of these activities on the day of his death.

RECOMMENDATIONS AND DISCUSSION

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but represent research presented in the literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order, and are not necessarily listed in order of priority. This preventive strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity (fitness). Steps that could be taken to accomplish these include:

Recommendation #1: Fire Fighters should have periodic medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of periodic medical evaluations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters¹⁴, and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹⁵ If these medical evaluations diagnose a previously unidentified medical condition, the condition should be checked against the medical

conditions that **should** (Category A) or **could** preclude (Category B) individuals from performing fire fighter activities.¹⁴

Applying NFPA 1582 involves legal issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses these issues in Chapter 8-7.1 and 8-7.2.¹⁵ The success of medical programs hinges on protecting the affected fire fighter. Revised NFPA standards should be implemented by the Department's retained physician responsible for fire fighters. To encourage full participation for all fire fighters, we encourage **negotiation** by the Fire Department and the Union to phase in utilization.

Recommendation #2: The Fire Department's physician should approve, in a confidential, nondiscriminatory manner, all medical information and recommendations for return-to-work clearances from personal physicians.

Currently, medical return-to-work information is treated as administrative, not confidentially evaluated by the Department physician responsible for ensuring fitness-for-duty for fire fighters.

Recommendation #3: Individuals with medical conditions that would present a significant risk to the safety and health of themselves or others should be precluded from fire fighting activities.

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The victim had numerous, serious medical conditions which, according to NFPA 1582, could have precluded him from fire fighter activities. According to Department records, the victim was restricted from fire suppression, but not Incident Command, since 1996. This restriction was made by a physician not likely familiar with the demanding Incident Command activities of a Sector Captain.

The victim had documented histories of angina, severe CAD, reduced left ventricular ejection fraction during his 1996 angioplasty, past medical history of coronary artery bypass surgery, poorly controlled hypertension and diabetes, the use of cardiovascular medications, lack of conditioned physical activity, and moderate obesity. Although he was not engaged in fire suppression activities at the time of his death, the medically documented severity of his CAD and other chronic diseases, unfortunately, put both his colleagues and himself at a significant safety risk in an emergency situation.

Before assuming the role of Sector Captain, the victim served as a Captain in an administrative capacity at another station. He requested the Sector Captain position, which was a lateral career transfer, because he preferred those duties.

Recommendation #4: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by offering a wellness/fitness program for fire fighters.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.¹⁵ In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve

fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual with a video detailing elements of such a program.¹⁶ Fire departments should review these materials to identify applicable elements for their department.

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INVESTIGATOR INFORMATION

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